Michigan Department of Environmental Quality
Water Bureau
February 2007

Total Maximum Daily Load for *E. coli* for Albrow Creek Jackson County

INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *E. coli* that will result in the attainment of the applicable WQS in Albrow Creek (also known as the Foster-Dodd Drain), a tributary of the Grand River, located in Jackson County, Michigan.

PROBLEM STATEMENT

The TMDL reach for Albrow Creek appears on the 2006 Section 303(d) list as:

ALBROW CREEK WBID#: 082816J
County: JACKSON SIZE: 1 M
Location: From Rives-Eaton Road u/s to Rives Junction Road
NHD Reach Code: 04050004000616
Problem Summary: Untreated sewage discharge, pathogens (Rule 100).
TMDL Year(s): 2007

Albrow Creek was placed on the Section 303(d) list due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli* (Edly and Wuycheck, 2006). Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2005 documented exceedances of the WQS for *E. coli* at all sampling locations during the total body contact recreational season of May 1 through October 31 (Table 1). Data collected during 2005 indicates that the TMDL reach needs to be extended to the upper limits of Albrow Creek for a total distance of three miles. The 2008 Integrated Report will reflect this revised listing. This TMDL addresses the entire 3.0 mile reach.

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. The designated use rule [Rule 100 (R 323.1100) of the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended] states that all waters be protected for total body contact recreation from May 1 to October 31. The target level for this TMDL is derived from Rule 62 of the WQS as follows:

R 323.1062 Microorganisms.
Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *E. coli* per 100 milliliters (ml), as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during five or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of three or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 ml. Compliance shall be based on the geometric mean of three or more samples taken during the same sampling event at representative locations within a defined sampling area.

For this TMDL, the WQS of 130 *E. coli* per 100 ml as a 30-day geometric mean and 300 *E. coli* per 100 ml as a daily maximum WQS are the target levels for the TMDL reach from May 1 to October 31.

DATA DISCUSSION

Albrow Creek was sampled for *E. coli* weekly at three stations from May through September 2005 (Figure 1). Thirty-day geometric mean *E. coli* concentrations ranged from 320 *E. coli* per 100 ml in June at Broughwell Road (Station 3) to 2218 *E. coli* per 100 ml in July at Rives-Eaton Road (Station 1; Table 1, Figure 2). The 30-day geometric mean WQS was exceeded throughout the entire sampling season at all three stations. Daily maximum concentrations ranged from 99 *E. coli* per 100 ml in May at Rives-Eaton Road to 7058 *E. coli* per 100 ml in July at Broughwell Road (Table 1, Figure 3). Daily maximum concentrations exceeded the 300 *E. coli* per 100 ml WQS, for all but 1 of the 21 sampling dates at Rives-Eaton Road, all but 2 sampling dates at Wood Road (Station 2), and all but 3 sampling dates at Broughwell Road.

E. coli monitoring was also conducted in Albrow Creek by the Jackson County Health Department from May through September 2002, at Wood Road and Broughwell Road. The data collected at these stations indicates that *E. coli* levels exceeded the daily maximum WQS on several occasions (JCDC, 2003).

Rives Township has received complaints from residents of the unincorporated village of Rives Junction concerning raw sewage in the basements of several homes. In 2001, Rives Township conducted fecal coliform sampling in the storm sewers within the village. Results indicated elevated levels of fecal coliform, an indicator of fecal contamination, in the storm sewers, which discharge to Albrow Creek (OMM, 2006).

SOURCE ASSESSMENT

The Section 303 (d) listed reach for Albrow Creek is one mile long, beginning at Rives-Eaton Road upstream to Rives Junction Road. As indicated in the numeric target section the listing will be revised in 2008 to include an additional two miles of stream. The unincorporated village of Rives Junction is within the TMDL reach watershed, and the TMDL reach is entirely within Rives Township of Jackson County (Figure 1).

The primary *E. coli* sources to this water body are most likely failing or improperly functioning septic systems and illicit connections to storm sewers in the unincorporated village of Rives Junction. Many of the village residential lots are very small and historical records show that

when septic tanks were installed, there was often not enough room for a drain field. Most residents hooked up their septic tanks to existing storm sewer drainage tiles, while others connected residential plumbing directly to the tiles. The storm sewer collection system discharges to Albrow Creek (OMM, 2006). Rives Township was issued a Notice of Noncompliance by the MDEQ in 2001 due to evidence traced back to 1977 that raw sewage was being discharged from the unincorporated village of Rives Junction to Albrow Creek. In 2001, OMM Engineering Inc. was hired by the township to investigate sewage treatment options (OMM, 2006).

To assist in determining potential sources of *E. coli* to Albrow Creek, a load duration curve analysis was developed for each sampling station as outlined in a paper by Cleland (2002). A load duration curve considers how flow conditions relate to a variety of pollutant sources (point and nonpoint sources). The load duration curves for each station sampled on Albrow Creek are included in Figures 4-6. Albrow Creek does not have a stream flow gage; therefore, the flows of a gage from a stream with similar geological characteristics were used to develop load duration curves. The United States Geological Survey gage used to determine the load duration curves is located on the East Branch Pine River, near Tustin, Michigan (Gage #04124500). A ratio of the drainage area of Albrow Creek to the drainage area of the East Branch Pine River at the stream gage (defined as the drainage area ratio), was calculated for each of the three sample locations on Albrow Creek. The curves were generated by applying these drainage area ratios to East Branch Pine River flows for the period of record, which includes all historical flows available for the East Branch Pine River gage.

The data indicate that exceedances of the daily maximum WQS are observed during wet and dry weather events (Table 1). However, the majority of the *E. coli* WQS exceedances occurred during dry weather conditions (Table 1; Figures 4-6). Note that dots above the curve on the left side of the figure are indicative of *E. coli* WQS exceedances during wet weather conditions (higher flows) and dots above the curve to the right side of the figure indicate *E. coli* WQS exceedances during dry weather conditions (lower flows). These dry weather exceedances indicate that sources of *E. coli* are most likely not related to precipitation events (i.e., runoff). The most likely source of *E. coli* is a constant source, such as failing septic systems throughout the watershed and illicit connections to storm sewers in the unincorporated village of Rives Junction.

It should be noted that exceedances of the daily maximum *E. coli* standard occurred not only downstream of the unincorporated village of Rives Junction, but upstream as well (Figure 6). Failing septic systems from residences located upstream of the unincorporated village of Rives Junction are also a possible source of *E. coli* to Albrow Creek.

Exceedances of the daily maximum *E. coli* WQS at all three stations also occurred during wet weather events. Precipitation data for the two days prior to each MDEQ sampling event were obtained from a weather station near the Reynolds Municipal Airport, west of Jackson, Michigan (Table 1; Weather Underground, 2006). Agriculture runoff, failing septic systems, and pet or wildlife wastes are possible sources of *E. coli* during wet weather. Agriculture, including grass and pasture land, accounts for approximately 59 percent of the land use in the TMDL watershed. The remaining land use includes 28 percent forest, 11 percent water, <1 percent commercial, and <1 percent residential (Choi and Engel, 2005). *E. coli* have been shown to enter water bodies from pastureland runoff and land applications of manure via field drainage systems, such as tiles and direct runoff. Field tiles provide for significant transport of intestinal bacteria through tile drainage systems under all manure application protocols and

environmental conditions (Jamieson et al., 2002). Overland runoff from land application of manure is another possible source of *E. coli* (Oliver et al., 2005).

There are no National Pollutant Discharge Elimination System (NPDES), including Municipal Separate Storm Sewer System and Concentrated Animal Feeding Operation, permitted discharges in the Albrow Creek watershed.

LOADING CAPACITY DEVELOPMENT

The loading capacity (LC) represents the maximum daily loading that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the targets for this pathogen TMDL are the 30-day geometric mean WQS of 130 *E. coli* per 100 ml and daily maximum WQS of 300 *E. coli* per 100 ml. Concurrent with the selection of numeric concentration endpoints, development of the LC requires identification of the critical conditions. The "critical condition" is the set of environmental conditions (e.g., flow) used in developing the TMDL that result in attaining WQS and has an acceptably low frequency of occurrence. The critical conditions for the applicability of WQS in Michigan are given in Rule 90 (R 323.1090), Applicability of WQS, which requires that the WQS apply at all flows equal to or exceeding the water body design flow.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli*, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration based, consistent with R 323.1062, and the TMDL is equal to the target concentration of 130 *E. coli* per 100 ml as a 30-day geometric mean and daily geometric mean of 300 *E. coli* per 100 ml in all portions of the TMDL reach for each month of the recreational season (May through October). Expressing the LC as a concentration equal to the WQS ensures that the WQS will be met under all flow and loading conditions.

LC

The LC is the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the LC must include a margin of safety (MOS), either implicitly within the WLA or LA, or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$LC = \sum WLAs + \sum LAs + MOS$$

The LC represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall LC is subsequently allocated into WLAs for point sources, LAs for nonpoint sources, and the MOS.

Because this TMDL is concentration based, the LC is equal to the 30-day geometric mean WQS of 130 *E. coli* per 100 ml and daily maximum WQS of 300 *E. coli* per 100 ml.

WLAs

There are no NPDES permitted point source discharges to Albrow Creek; therefore, the WLA is equal to zero. If future growth in the Albrow Creek watershed requires that this WLA be expanded, this TMDL may be modified.

LAs

The LA is equal to the 30-day geometric mean WQS of 130 *E. coli* per 100 ml and daily maximum of 300 *E. coli* per 100 ml. This LA is based on the assumption that all nonpoint sources, regardless of land use, will be required to meet the WQS. Therefore, the relative responsibility for achieving the necessary reductions of *E. coli* and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction of the local unit of government in the watershed. The TMDL reach and the entire Albrow Creek watershed (6.5 square miles) is located in Rives Township, Jackson County, Michigan.

MOS

The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality, including the pollutant decay rate if applicable. The MOS can be either implicit (i.e., incorporated into the WLA or LA through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay was used. Ordinarily, pathogen organisms have a limited capability of surviving outside of their hosts and a rate of decay could be developed. However, applying a rate of decay could result in an allocation that would be greater than the WQS, thus no rate of decay is applied in order to provide for a greater protection of water quality.

SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. The total body contact recreation standards as described in the Numeric Target section are more restrictive than those for the partial body contact recreation season (November 1 through April 30) and therefore controls designed to achieve the TMDL goals should assure that WQS for *E. coli* are met year-round.

MONITORING

Pathogens were monitored weekly at three stations on Albrow Creek. Monitoring occurred from May through September 2005. Future monitoring will take place as resources allow, as part of the five-year rotating basin monitoring. When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml and daily maximum value of 300 *E. coli* per 100 ml are being met.

REASONABLE ASSURANCE ACTIVITIES

The Grand River Environmental Action Team and The Upper Grand River Watershed Council are two community groups working in the Upper Grand River watershed, which includes Albrow Creek. The mission of the Grand River Environmental Action Team is “to promote, through activities and educational programs, public awareness for the need to protect the Grand River, including its watershed and surrounding wetlands in Jackson County, Michigan.” The Upper Grand River Watershed Council developed the Upper Grand Watershed Management Plan in 2003. The plan included *E. coli* data collected in Albrow Creek in 2002, by the Jackson County

Health Department. Data indicated exceedances of the daily maximum of 300 *E. coli* per 100 ml on several occasions. The watershed plan indicates that the unincorporated village of Rives Junction had received a rural development grant to address the failed septic system issues; however, current information indicates the grant has not yet been secured. The plan recommends that, as a best management plan, there should be continued efforts to fund, design, and construct sanitary sewer connections for homes in the unincorporated village of Rives Junction discharging sewage to Albrow Creek (JCDC, 2003).

Rives Township is currently evaluating their options to replace the septic systems within the unincorporated village of Rives Junction. They have hired OMM Engineering Inc. who has developed a "Preliminary Engineering Report for Wastewater System Improvements" on behalf of the township (OMM, 2006). Rives Township would like to build a sanitary sewer system in the unincorporated village of Rives Junction and connect it with the sanitary sewer line of neighboring Blackman Township, which is connected to the city of Jackson Wastewater Treatment Plant. However, funding for this project is not currently available. The township is in the process of applying for a grant from the United States Department of Agriculture, Rural Development Office, to fund the project. The Rural Development Office is waiting for the United States Congress to pass a budget that will determine what the 2007 grant allocations will be. The township is anticipating that a mix of grants and loans will be necessary to fund the project, which has an anticipated approximate cost of $2,575,000.

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Table 1. MDEQ 2005 *E. coli* monitoring data (*E. coli per* 100 ml) for Albrow Creek. Data are presented downstream to upstream.

	Albrow Creek @ Rives-Eaton Road (Station 1)			Albrow Creek @ Wood Road (Station 2)			Albrow Creek @ Broughwell Road (Station 3)			Prior 2-Day Precipitation in inches
DATE	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	
5/11/2005	120	99	---	840	416	---	60	210	---	0.12
	100			860			700			
	80			100			220			
5/18/2005	360	494	---	100	117	---	860	866	---	0.79
	540			160			840			
	620			100			900			
5/25/2005	460	488	---	100	134	---	120	134	---	0
	420			80			200			
	600			300			100			
6/1/2005	3000	2240	---	200	413	---	420	273	---	0.12
	2400			800			220			
	1560			440			220			
6/8/2005	320	1071	564	1340	1627	338	560	506	320	0
	1600			1460			400			
	2400			2200			580			
6/15/2005	940	992	895	100	423	339	820	844	423	0
	880			880			940			
	1180			860			780			
6/22/2005	400	543	912	900	1003	520	1000	1058	440	0
	400			800			800			
	1000			1400			1480			
6/29/2005	1200	1423	1129	2200	1681	863	4600	3978	867	0.31
	2000			1800			3800			
	1200			1200			3600			
7/6/2005	5200	4437	1295	1200	1629	1136	600	549	998	0
	4000			1800			600			
	4200			2000			460			
7/13/2005	2800	3269	1619	1400	3467	1321	3200	7058	1689	0.04
	5200			12400			8200			
	2400			2400			13400			
7/20/2005	400	1048	1637	1200	848	1518	1140	1762	1957	1.26
	1800			540			2000			
	1600			940			2400			
7/27/2005	1600	2479	2218	5400	3115	1905	1600	1724	2158	0.63
	3400			1000			1600			
	2800			5600			2000			

Table 1 continued.

	Albrow Creek @ Rives-Eaton Road (Station 1)			Albrow Creek @ Wood Road (Station 2)			Albrow Creek @ Broughwell Road (Station 3)			Prior 2-Day Precipitation in inches
DATE	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	SAMPLE RESULTS	DAILY MAX	30-day G. MEAN	
8/3/2005	1400 460 1400	966	2052	1600 1800 600	1200	1780	1400 1140 400	861	1589	0
8/10/2005	1600 1400 2800	1844	1722	1660 2000 1800	1815	1819	2600 1020 940	1356	1904	0.04
8/17/2005	1400 280 800	679	1258	1200 500 260	538	1254	400 600 600	524	1132	0
8/24/2005	800 1800 800	1048	1258	200 520 480	368	1061	220 1000 1400	675	934	0
8/31/2005	600 200 1200	524	922	800 800 800	800	808	1200 800 400	727	786	0
9/7/2005	800 4400 60	596	837	400 300 200	288	608	200 340 280	267	622	0
9/14/2005	2000 480 360	702	690	600 120 600	351	438	1400 600 400	695	544	0
9/21/2005	480 600 800	613	676	60 580 440	248	375	1000 260 200	373	509	0
9/28/2005	600 400 1000	621	609	560 440 500	498	398	800 1000 <20	894	519	0.2

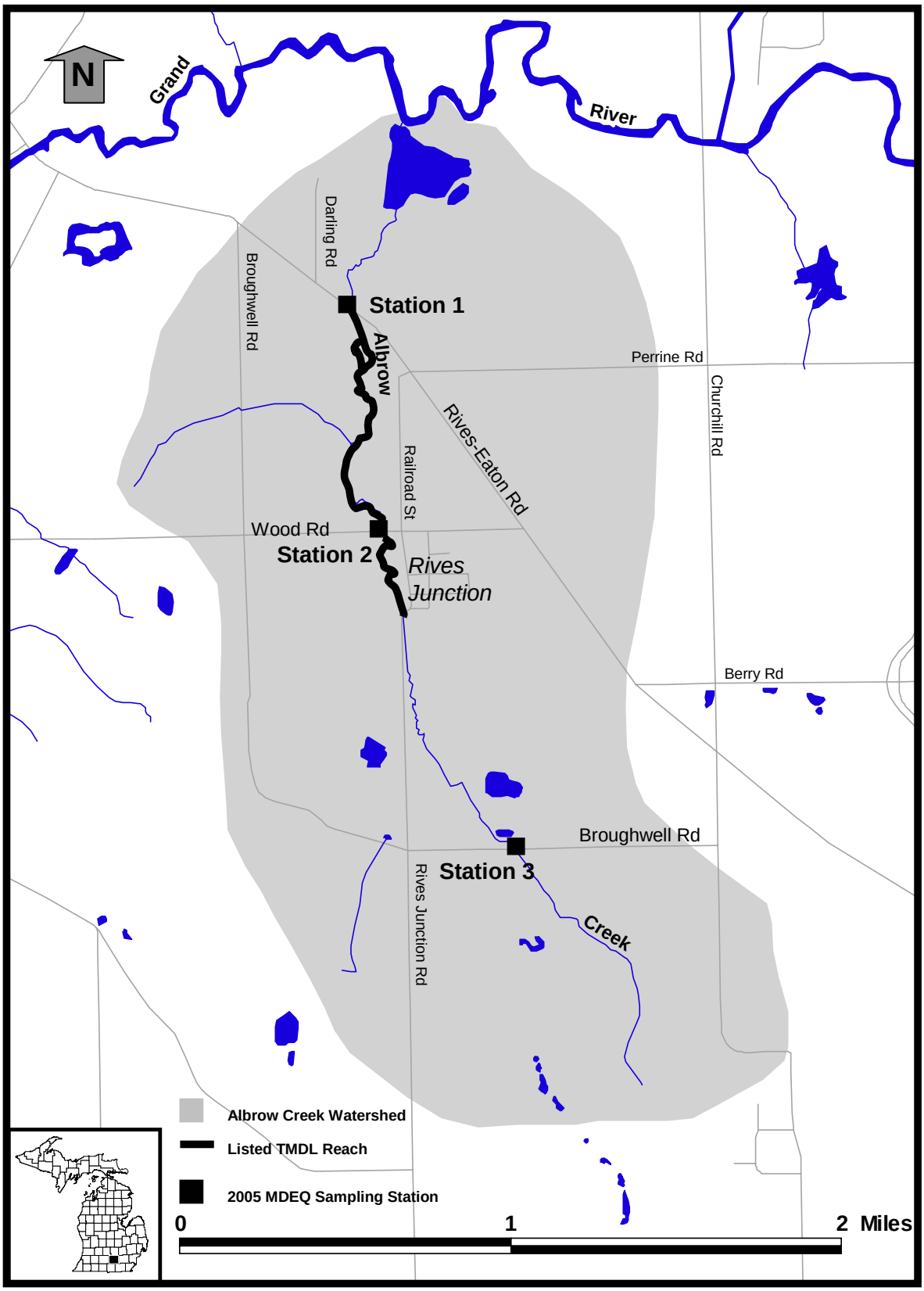

Figure 1. Albrow Creek watershed and *E. coli* sampling locations, Rives Township, Jackson County, Michigan, 2005.

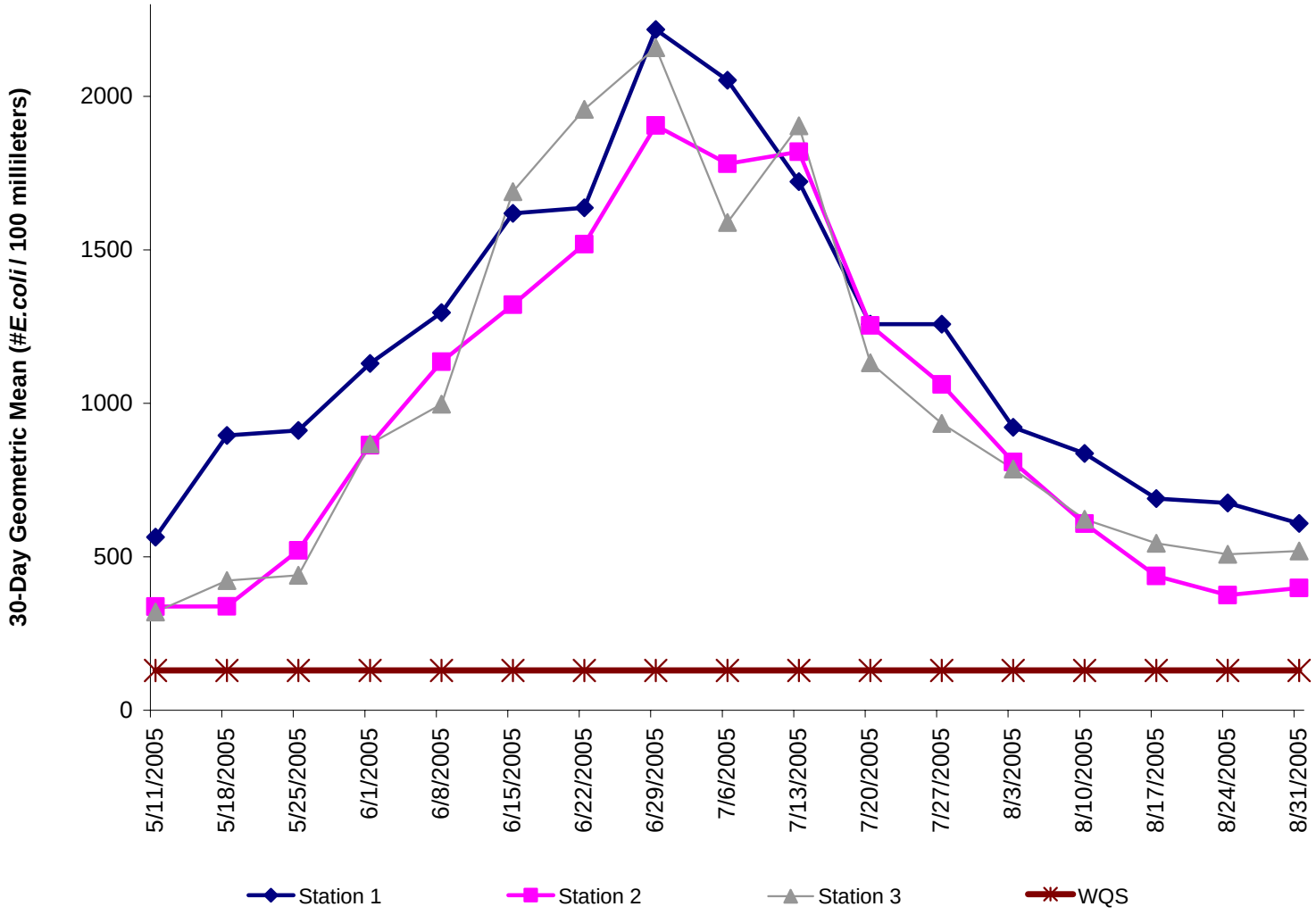

Figure 2. 30-day geometric mean values for *E. coli* in Albrow Creek, Jackson County, Michigan, 2005. Stations are listed from downstream to upstream location.

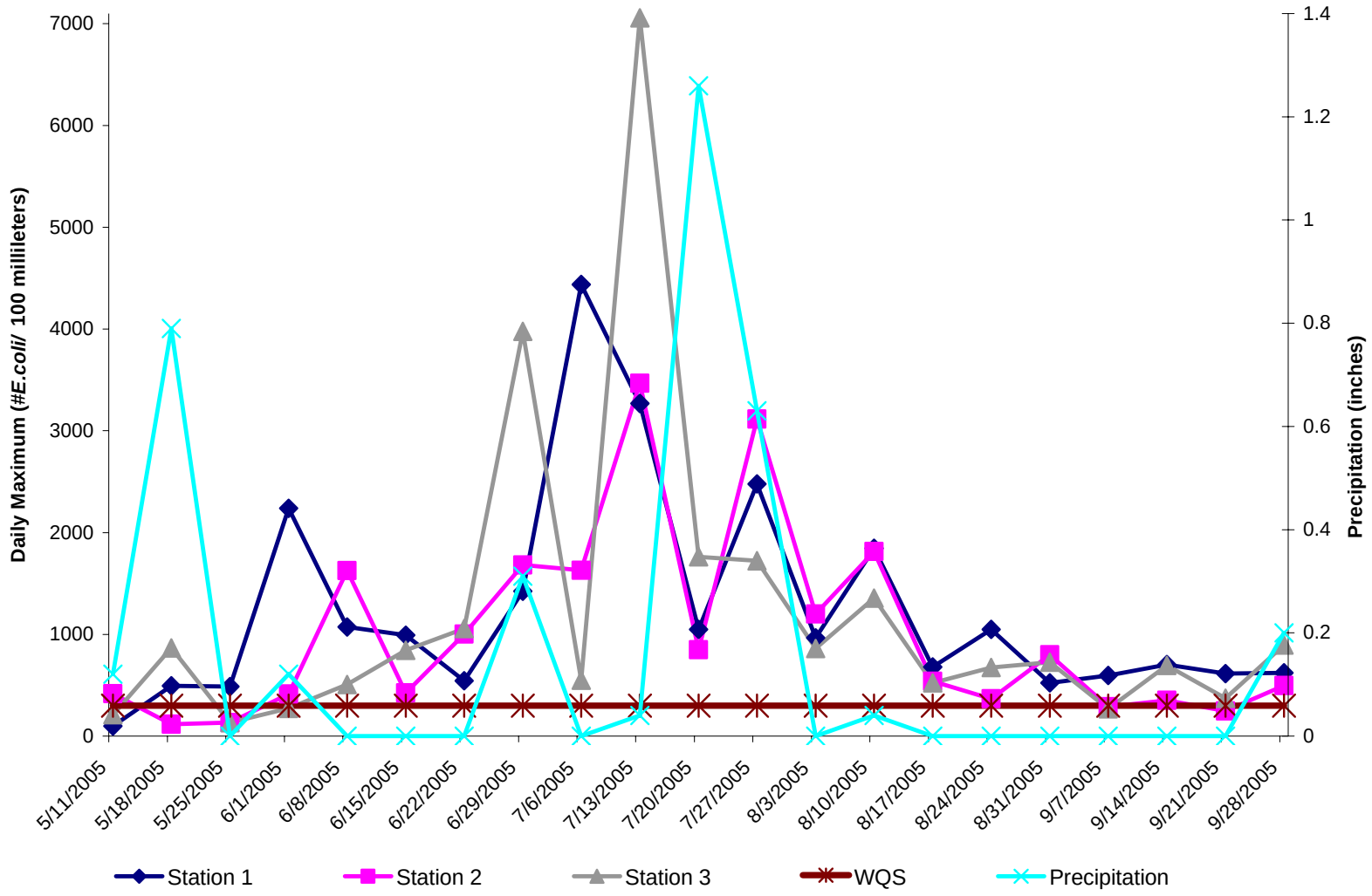

Figure 3. Daily maximum values for *E. coli* with prior 2-day precipitation values in Albrow Creek, Jackson County, Michigan, 2005. Stations are listed from downstream to upstream location.

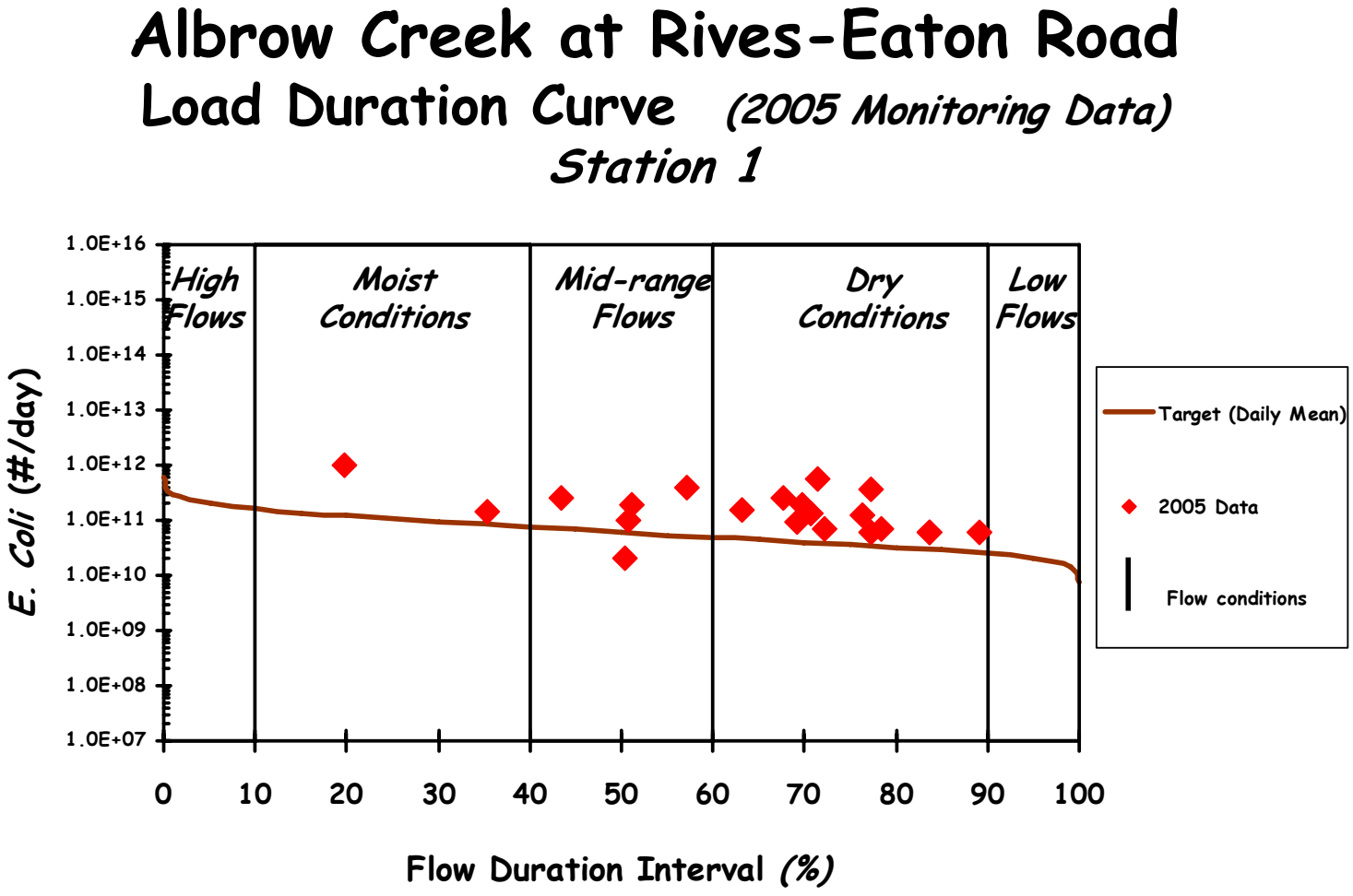

Figure 4. Albrow Creek at Rives-Eaton Road (Station 1). Load duration curve based on daily maximum concentration values.

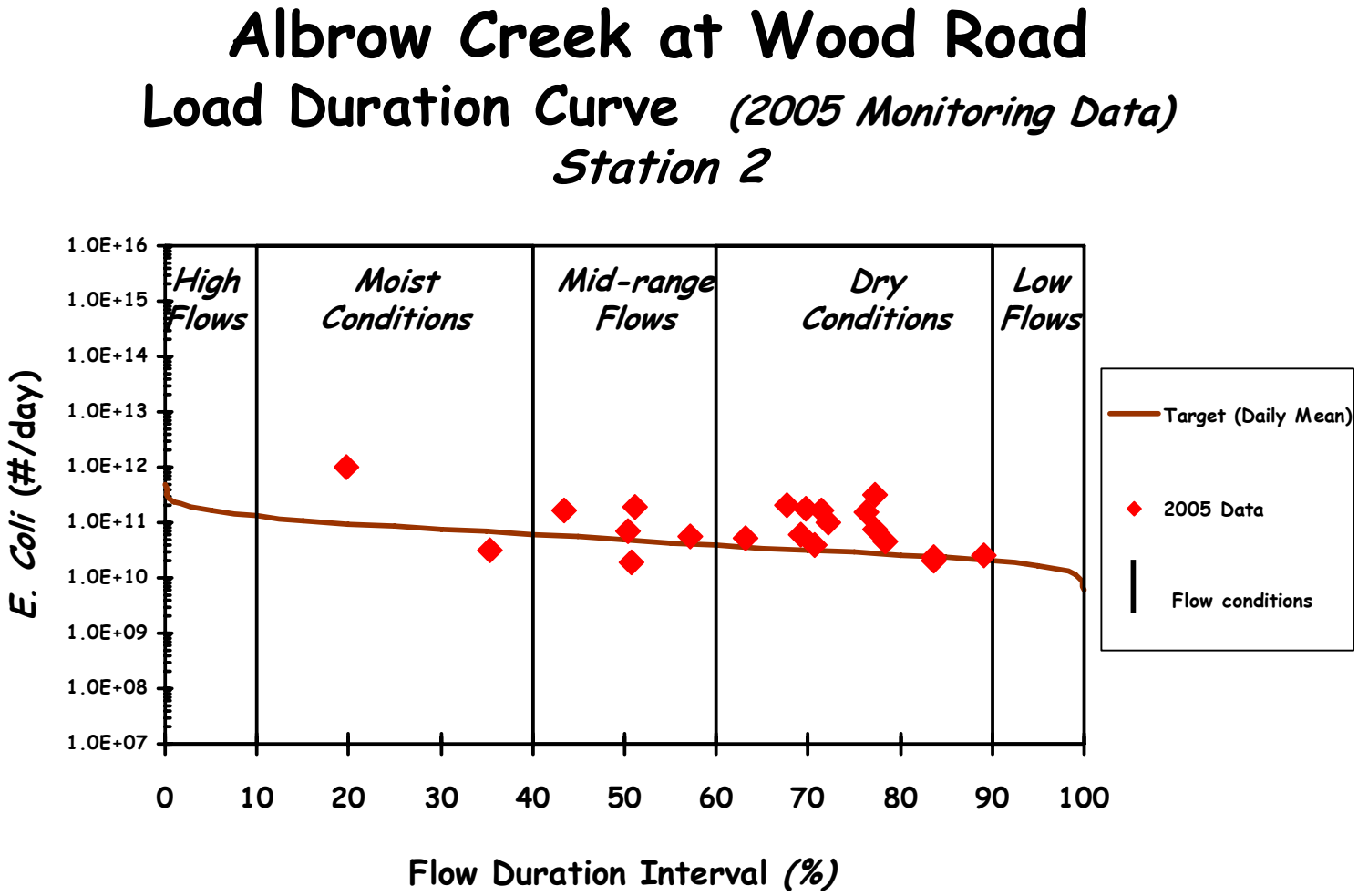

Figure 5. Albrow Creek at Wood Road (Station 2). Load duration curve based on daily maximum concentration values.

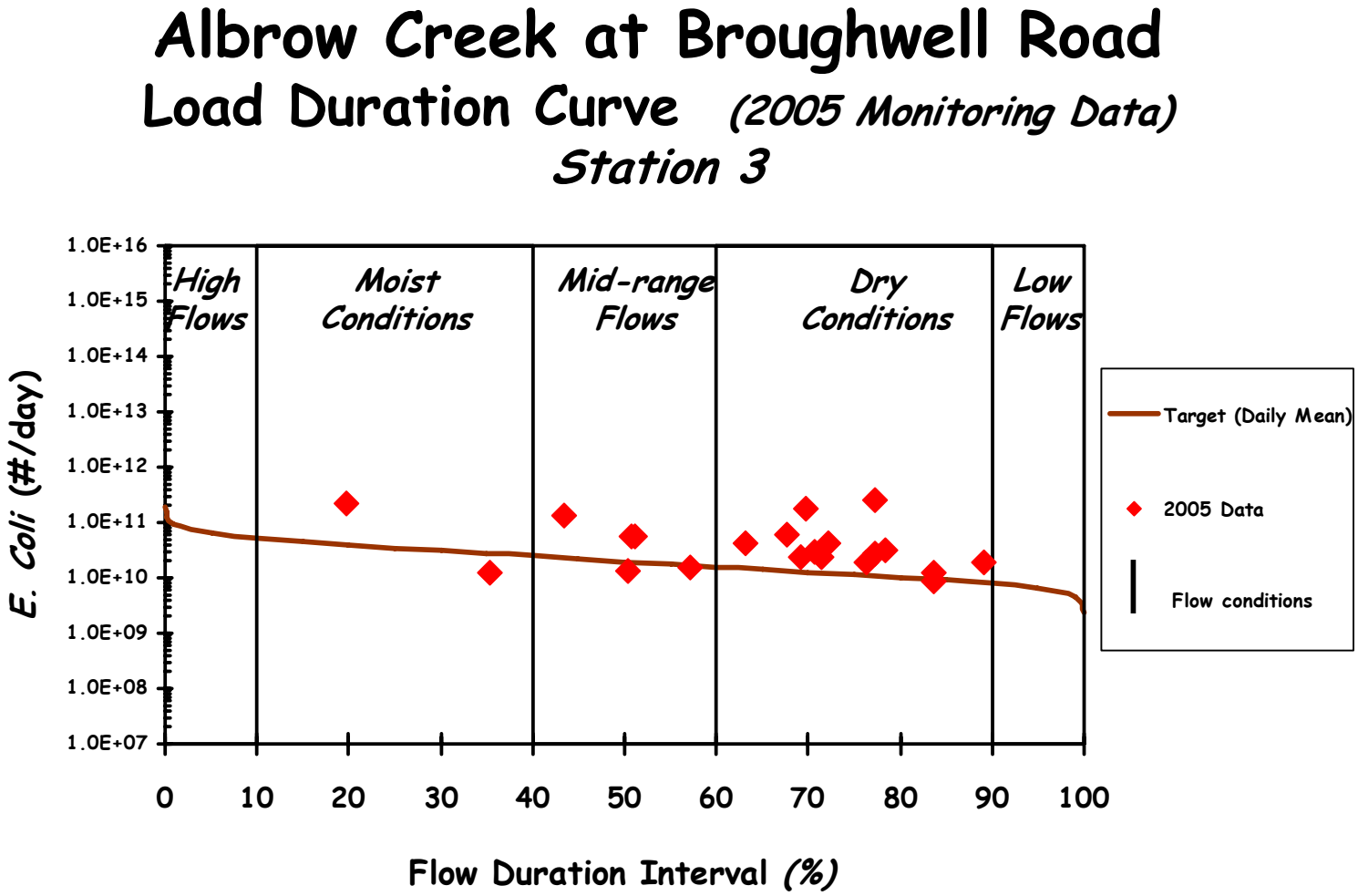

Figure 6. Albrow Creek at Broughwell Road (Station 3). Load duration curve based on daily maximum concentration values.